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23. STUDIES ON THE BIOLOGY OF THE DOG-WHELK *NASSASTOLATA* (GMELIN) OF PORTONOVO WATERS

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ABSTRACT

The morphology, anatomy and sex ratio of the mud snail *Nassa stolata* (Gmalln) were studied. The species, being a facultative omnivore. feeds mainly on dead animals and the digestive system Is suited to this mode of feeding. The radula is of rachiglossate type and is well suited for tearing and rasping. The female reproductive system Is mors complicated than that of male- Studies on sex ratio clearly show the prepondarence of males over females. The males mature at a size of 12.1 mm female* at 12.5 mm.

INTRODUCTION

Studies on the functional morphology and anatomy of neogastropods are few. These groups of animals by virtue of their several advanced chracters lil^e internal fertilization, facultative omnivorous feeding habit, and highly developed sense of chemoreception have been studied by Peile (1922, 1936), Graham (1939, 1941, 1949), Fretter (1941), Jennerand Chamberlain (1955), Oisson (1956), Fretter and Graham (1962), Marcus and Marcus (1959,

1962), Brown (1959) and Ponder (1970, 1972, 1973). Among nassarids the European species *Nassarius obsoletus* has been studied by several authors (Bergman and Graham 1975; Scheltema 1956, 1962, 1964, 1965; Pachenik 1978). Knowledge on the sex composition and sexual dimorphism is of vital importance in understanding the population structure of any animal community. However information on the tropical nassarids is almost nil. The present study is aimed to throw some light on the morphology, anatomy and sex ratio of *Nassa stolata* collected from the Vellar estuary (Lat. ir29'N; Long 79°46'E).

MATERIAL AND METHODS

The animals were collected from the benthc region of the Vellar estuary (Fig 1). Theanimal was removed from the shell by breaking open it or boiling m mild alkaline solution. Length, width and height of the shell and operculum were measured with a vernier calliper. Dissections were carried out both on live and preserved animal to study anatomy and drawings were made with camera lucida. The radula was studied by dissolving the tissues of probosis in 10% sodium hydroxide. The radular ribbons were mounted on a clear glass slide with a drop of 4% acetic acid and the drawings were made. In the present study an attempt was also made on this animal whether this species

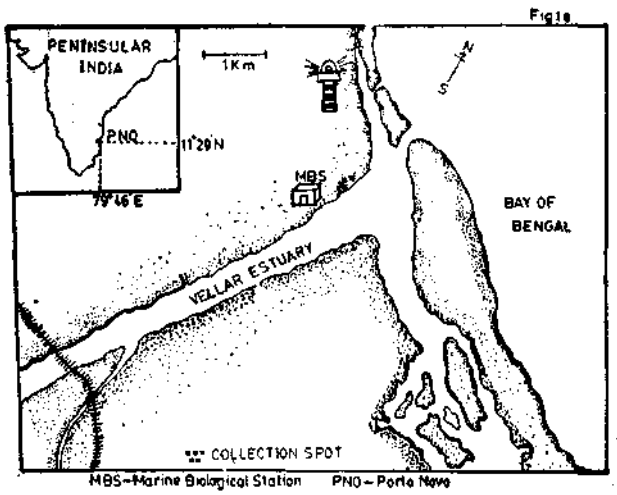


Fig. 1 Map of the Vellar estuary showing the collection area.

ing the chl-square test. The size at first maturity was observed by gonadial smear examinations and by histological sections following the pocedures of Alagarswami (1966) and Nagabhusanam and Mane (1975).

RESULTS

Shell and Operculum Morphology

globosely increased spires. The aperture inside. The inner surface of the outer lip has small ribs which are not well pronounced. A short siphonal canal is present in the anterior part of the shell. The shell surface has strong transpiral ribs which make it rough, Columella is without marked callus thickenmg. The shell is dark brown with bands. The she I measured about 6.9 mm in width and 4.0 mm to 5.4 mm in height. The whorls are 6 to 7 in number,

The operculum is elongately ovate with a terminal nucleus and measures about 2.5 mm to 3.0 mm in width and 3.0 to 4.5 mm in diameter. It has teethed margin and closely fits the aperture when the foot is retracted,

Head. Penis, Tentacle (Fig, 2 A-B)

The head is light red; the tentacles are moderately long with dot like eyes near the base. The probosis protrudes from below the tentacles at the tip of which the mouth is present. The penis which is tugged in the mantle skirt below the right cephalic tentacle is laterally compressed and light yellow in colour throughout, with a wedge-shaped swollen end which bears the penial opening.

Pallial complex

i. Male (Fig 2. C)

The pallial complex contains the penis and anus on the extreme right side. The rectum parallels the pallial region of the male genital duct and opens through anus at the region where the base of the penis joins the head.

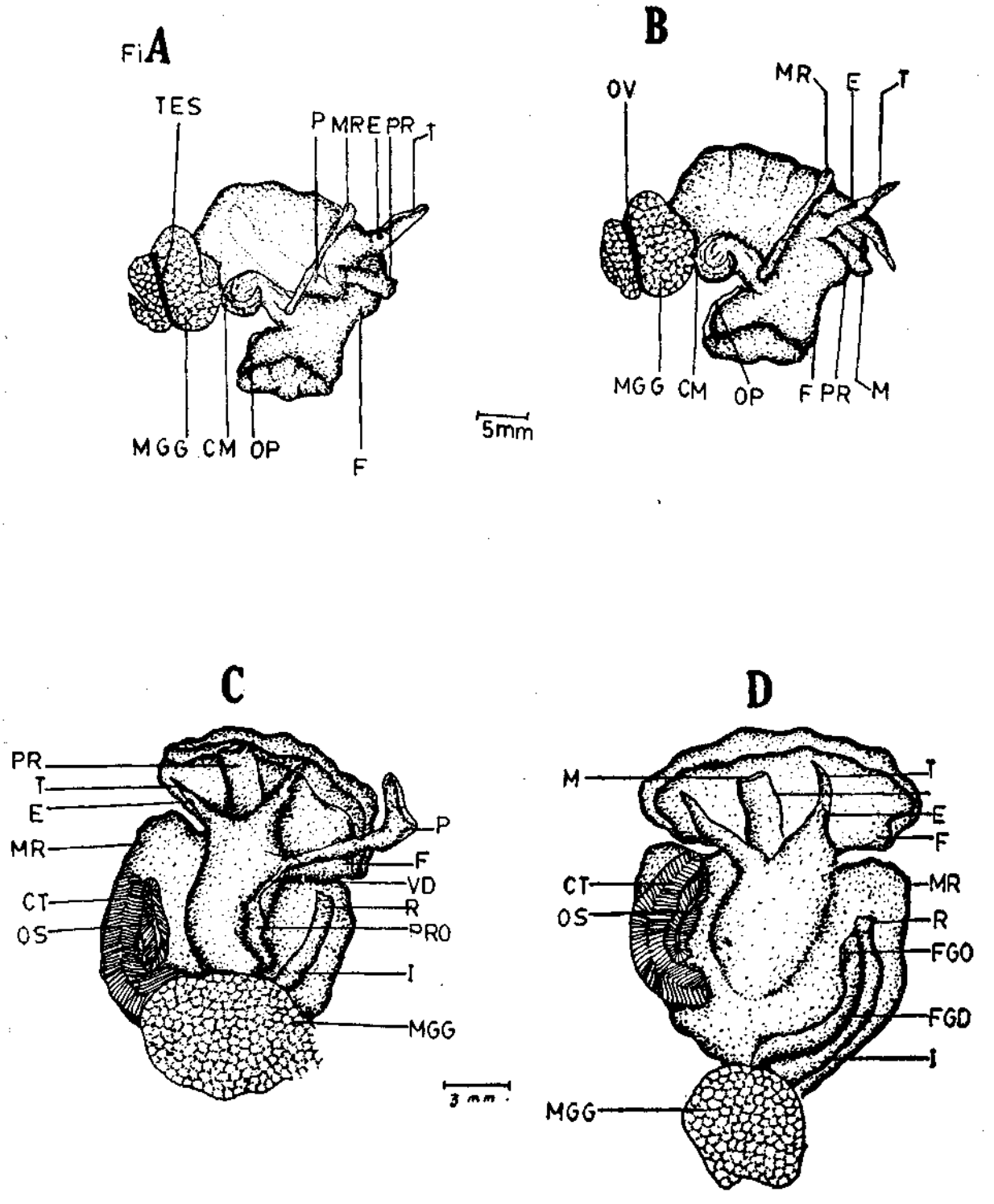


Fig 2. A: Male removed from the shell; B: Female removedfrom the shell; C: Pallial complex (Male); D: Palial complex (Female).

Description of figures (common figs. 2, 3 & 4)

A - Anus; AA - Anterior Aorta; AG • Albumen Gland; AO - Anterior Oesopliagus; BC — Buna Copulatrix: C -Capcum; CCM - Cerebral Comnissure; CG - Capsule Gland; CM - Columellar Muscle; CT - Ctenldium; E - Eyes; F • Foot{ FGO - Femsia Genital Ouct; FGO • Female Genital Opening; GL - Gland of Leiblein; GS - Gastric Shield I • Intestine; IG - Intestinal Groove; LAT • Lateral Tooth; M - Mouth; MAT - Major Typhlosaol; MGG - Mid Gut Gland; MIT • Minor Typhlosole; MO - Mid Oesophagus; MR - Mantle Roof; OD - Oviduct; OEO - Oesophageal opening; OP - Operculum; OS • Osphradium; OV - Ovary; P •-Penis; PO - Pedal Ganglion; PEO - Penial Duct; PO - Posterior Oesophagus; PR-Probosis; PRO-Prostats; R-Rectum; SV-Seminal Vesicle; T - Tentacle; TES • Testis; VD - Vas deferens;

The anterior region of the prostate lies in the pallial region.

ii. *Female* (Fig. 2, D)

The rectum runs next to the pallial oviduct, which lies on the extreme right side of the animal, and opens just below the female genital pore. Because of the presence of reproductive glands like albumen and capsule gland, the pallial oviduct is quite prominent than the rectum and can be seen by the transparency of the mantle when the animal is removed from the shell. The bipectinate osphradium and ctenidium occupy the left of the animal. The siphon becomes confluent with the mantle edge at the base of the osphradium. The kidney and heart lie in the posterior region of the mantle cavity and adjacent to each other.

Animal removed from the shell

Male (Fig 2, A)

The head-foot region which includes the tentacles with eyes on it and the mantle cavity are seen just after the animal is remsved from the shell. The mantle cavity extends from the head to the point where the visceral mass begins. The visceral mass Includes the posterior oesophagus, stomach, mid gut gland and testis The foot is pigmented with black spots. A pair of posterior tentacles are present at the posterior end of the foot which is clearly visible when the animal is crawling. The foot, when fully extended, may reach upto two third of the body length. The mantle skirt is thin, transparent and unpigmented throughout. Most of the organs housed within the mantle cavity can be recognised owing to its transparency. A large laterally compressed penis can be seen tugged into the mantle skirt.

Female (Fig 2 B)

The female shows a great degree of similarity to males in head-foot region except for the penis. In females, columellar muscle which occupies the ventral portion of the animal is white and wedge-shaped. At the posterior region where the oviduct enters into the pallial complex, albumen gland can be seen with the receptaculum seminis next to it- Near the anterior end of the pallial oviduct the capsule gland and bursa copulatrix are present. Running parelled with all these structures is the rectum **which opens outside by the anus.**

The viscera! mass is constituted largely by midgut glands. The midgut gland is dark green in colour and encircles the stomach except for a small portion on the ventral side. The inner-side of the apical whorl is occupied by the ovary which is orange in colour,

Anatomy

Digestive system {Fig 3 A)

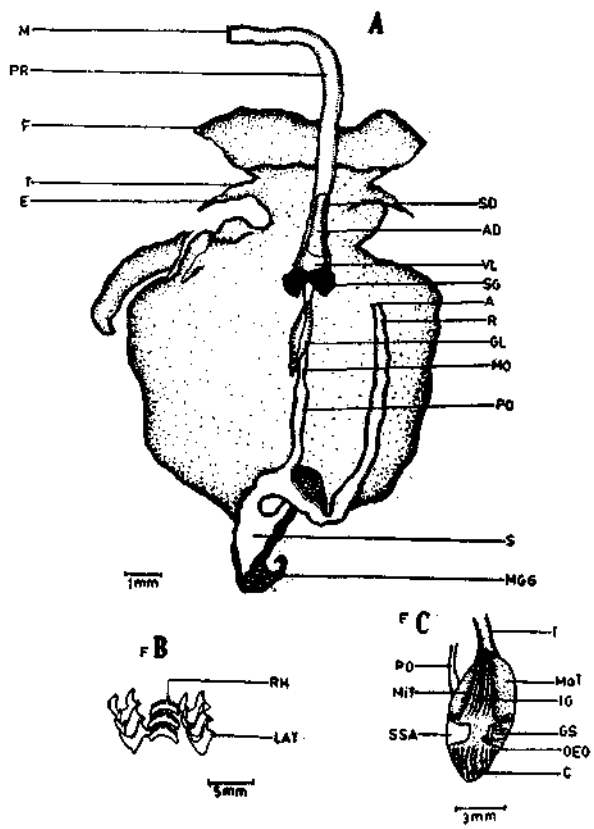
• *Pr H '*

'• ^^0'^°^'^

The protrusible probosis which forms the anterior buccal region is pleurembolie type gnd it enables the animal to feed on food materials at some distance The mouth is at the tip of the probosis, inside which lies the radula.

//. Radula (Fig 3, B)

The radula is located in the radular sac which lies ventral to the anterior oesophagus. It contains about 71-83 transverse rows of ^^^^^ and measures 3.5 mm in length and 0.31 ^^ •^^ ^idth. The radula shows the typical



p.^g ^. Di,^,,,^^ .howing the digestive system; g. ^he tr.nsver., row of r.dui.r teeth;

C: Cutopened view of the atomach.

rachiglossan pattern with one central and two marginal teeth. The central tooth contains 12 cusps.

///. Salivary glands

A pair of horse-shoe shaped, white coloured salivary glands are present on the dorsal side of the midoesophagus closely intermingling with each other. The ducts of the salivary glands passes anteriorly lateral to the anterior-oesophagus and opens into the mouth at the tip of the probosis

iv. Gland of L eiblein

The gland of Leiblein is brown in colour and measures 2 5 to 3.0 mm in length. It is a single, elongate organ which tapers to a point with undulated margin, which may be due to the lobrilar nature of the gland. The gland of Leiblein is close to the dorsal side of the oesophagus and ends halfway of the mid-eosophagus.

\^. Valve of Leiblein

The value of Leiblein is a cone shaped structure which marks the beginning of the mid-oesophagus. It measures about 1.2 to 1.5 mm length. It preventsthe reverse passage of the food into the anterior-oesophagus (Graham 1941) .

vi. Oesophagus

The oesophagus can be divided into anterior, mid and posterior oesophagus. The anterior, oesophagus is included in the probosis. At the lateral sides of the anterior oesophagus runs the salivary duct which opens into it near the mouth at the tip of the probosis. The beginning to the mid oesophagus is marked by the presence of valve of Leiblein where the gland of Leiblein opens. Then the oesophagus continues as the posterior oesophagus before enters into the stomach midventrally.

vii. Stomach (Fig 3, C)

The stomach Is a 'V shaped tubular sac with oesophagus and intestive [occupying the respective side of the 'V. The stomach has the greatest diameter in the middle and measures about 2.5 to 3.0 mm with its ends tapering to a point. The stomach is enveloped by the mid-gut gland except on the ventral side.

The stomach can be divided into anterior stomach which contains major and minor typhlogoles with intestinal groove between them and posterior stomach which contains no crystalline style but Brown (1959) reported the occurrence of one in *Nassarius obsoletus.* The midgut gland opens into the stomach by two groups of openings on the ventral floor. The posterior stomach is occupied by the cerecum.

viii. Intestine and Rectum

After leaving the stomach the intestine passes forward, slightly curved to the right side near the kidney and passes along the pallial wall It is wide at the beginning but reduces in diameter as it approaches the rectum. The rectum opens on the right side of the mantle roof.

Reproductive system

In *N. stolata* sexes are seperate. Males can be readily distinguished by the presence of the long penis. In both male and female the genital system starts with the gonadial tissue in the apical whorls of the animal and ends by their opening in the mantle roof. The male genital system is comparatively simpler than the female system.

/'. Male (Fig. 4, A)

The yellow coloured testis spreads over the mid gut gland in the ultimate and penultimate whorls. It is made up of numerous follicles and small ductules which join to form the genital ducts.

Immediately after leaving the testis on the posterior side, the vas deferens is thrown into numerous convolutions which form the seminal vesicle. The seminal vesicle, which ends just before the mantle cavity starts, is followed by a closed duct, yellow in colour

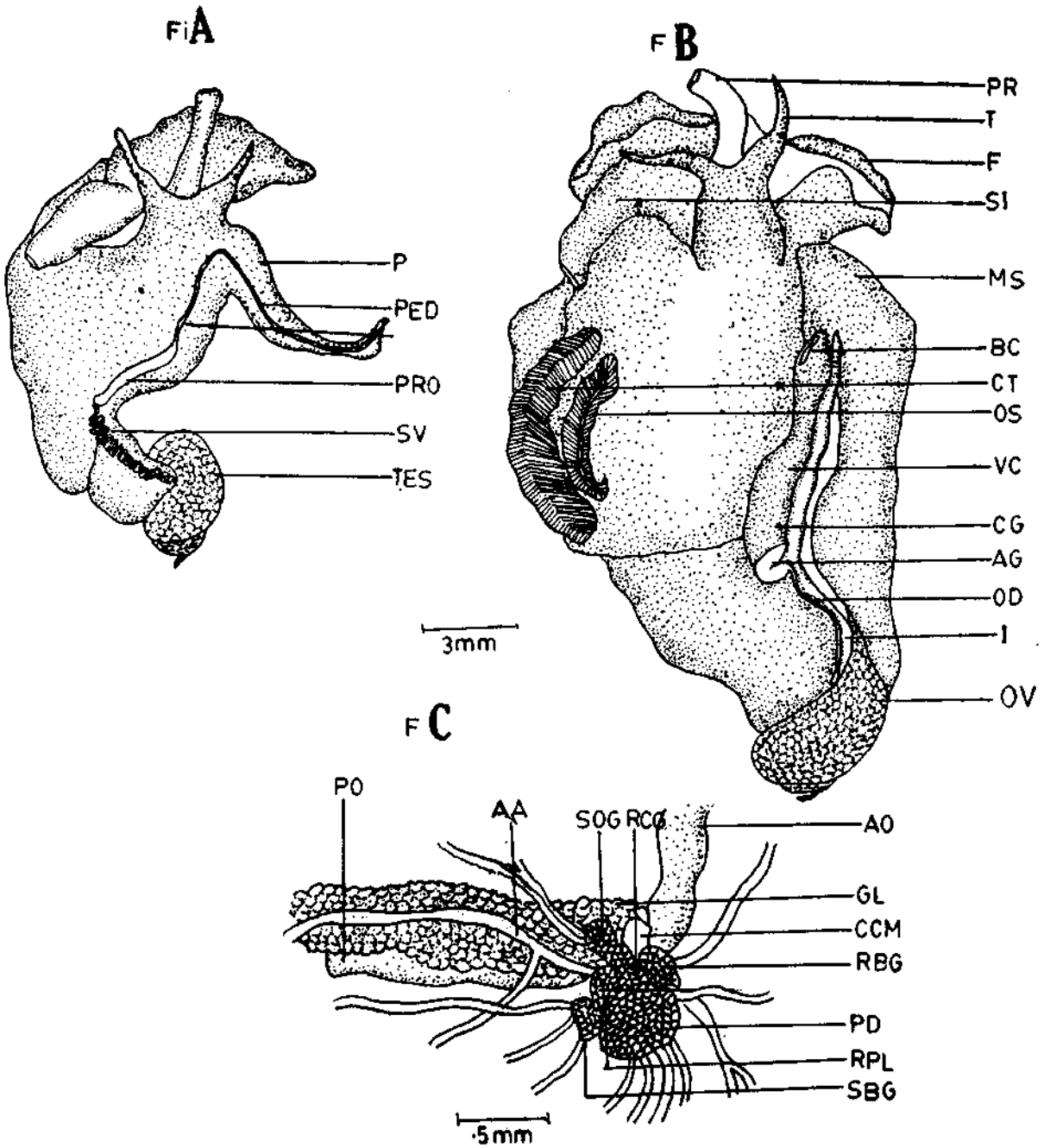


Fig 4, A: Dissection showing the male reproductive system
B. The female reproductive system
C: Dissection showing the nervous system.

with black streaks on the edge named as the prostate. It runs parallel to the rectum on the right side of the mantle cavity. The prostate is followed by the anterior vas deferens which terminates near the base of the penis. The penis IS a dorso-ventrally flattened structure below the right cephalic tentacle. The penial groove runs in the centre of the penis to the tip where it opens outside.

//. Female (Fig 4, B)

The light yellow coloured ovary les on the last two apical whorls. The oviduct emerges from the ovary, runs on the columellar aspect and joins with the albumen gignd by a small curve. The creamy white, inverted 'V shaped albumen gland constitutes the first part of the pallial oviduct. It opens into the ventral channel of the capsule gland.

The seminal receptacle is present between the capsule and albumen glands and opens at the junction on the dorsal side. The ducts of the ingesting gland usually act as a seminal receptacle storing the orientated spermatozoa (Ponder 1973).

The white coloured capsule gland occupies the greater part of the pallial oviduct. The ventral channel from the ventral side of it leads upto the junction where the ingesting gland opens into the albumen gland. The terminal part of the capsule gland ends as the vestibule and vagina. The ventral channel has two ciliated folds running over them. Ventral to the capsule gland and vestibule is the bursa copulatrix.

Nervous system (Fig 4, C)

The nervous system of *N. stolata* is of a "Concentrated" type with the ganglia around the anterior oesophagus forming a circum - oesophageal ganglionic ring. The ring is constituted by a pair of buccal ganglia, a pair of cerebal ganglia which are dorsal in position, a pair of pleural ganglia which are lateral in position and a sub and supra oesophagel and a large pedal ganglion. The nerves from these ganglia innervate various body parts.

Sex ratio

The male to female ratio in different months of the year (December 1982 to November 1983) is given in Table 1. It is clear from the results of the chi-square test that males dominate in all the months except November and July 1983 during which the females are dominant. The preponderance of males over females is well pronounced in March and May 1983 but the ratio is almost equal in December 1982 and February 1983. Despite few fluctuations the sex ratio was comparable in different months of the study period. The sex ratio of males and females were pooled to know their distribution among different length groups and the results are presented in Table 2. The dominancy of males over females is generally well pronounced in the larger size groups whereas in smaller size groups the females are dominant. The sex ratio calculated for the period of 3 years from 1982 to 1984 is enumerated in Table 3. In ail the

TABLE 1. *Sex ratio in* Nassa stolata *during different montfis (1982).*

Month*	Males	Famales	Ratio of males to females valua	Chi square valua	D.F.
Dec 1982	58	57	1.02:1	0.005	1
Jan	61	36	1.69:1	6.44	1
Feb	57	54	1.06:1	0.08	1
Mar	69	38	1.82:1	8.98	1
Apr	66	46	1.43:1	3.571	1
May	67	40	1.68:1	6.813	1
Jun	60	45	1.33:1	2.1428	1
Jul	53	57	0.93:1	0.1455	1
Aug	56	49	1.14:1	0.47	1
Sep	42	35	1.20:1	0.64	1
Oct	44	35	1.26:1	1.031	1
Nov	39	44	0.89:1	0.30	1

TABLE 2. *Sex ratio in* Nassa stolata *at different lengtti groups.*

Length groups	Males	Females	Ratio of male to female
7.6-8,0	3	5	0.60
8.1-8.5	6	5	1.20
8.6-9.0	7	8	0.88
9.1-9.5	10	8	1.25
9.6-10.0	8	11	0.73
10.1-10.5	6	3	2.00
10.6-11.0	2	3	0.67
11.1-11.5	1	4	0.26
11.6-12.0	5	5	1.00
12.1-12.5	6	2	3.00
12.6-13.0	28	21	1.33
13.1-13.5	44	36	1.22
13.6-14.0	95	76	1.25
14.1-14.5	106	58	1.83
14.6-15 0	146	125	1.17
15.1-15.5	87	76	**1.14**
15.6-16.0	89	64	1.39
16.1-18.5	18	16	1.13
16.6-17.0	9	4	2.25
17.1-17.5	2	1	2.00

TABLE 3. *Sex ratio in* Nassa stolata

Year	Males	Females	Ratio of males to females	Chi-square value
1983	614	479	1.28:1.0	16.67
1984	367	301	1.22:1.0	6.52
1985	269	204	1.32:1.0	893

Significant at 0.1% level.

three years the male : female ratio was not 1:1 as hypothesized but the males are dominant in all the three years.

The monthly gonadial smear observations shows that the first indication of sex cells appear in males at the size of 12.1 mm and in females at 12 5 mm. The sex cells are incipient below 10 mm in both the sexes examined. Scheltema (1964), in his study on *N. obsoletus,* found that the animals attained sexual maturity at 12.0 to 14.0 mm length. Which is higher than the values found in the present study.

DISCUSSION

The shell in most neogastropods is large, usually fuseform, rather heavy and has a long anterior siphonal canal and the animal can be withdrawn into it completely. The presence ofcolumellar plaits provide additional surface for the attachment of columellar muscle in Turbinellidae and in some Faciolariidae are absent in *N. stolata.* The shell of female is larger in size than that of males which clearly indicate their sexual dimorphism which is the case in *Buccinum undatum* also (Hallers-Tjabbers 1977). The shallow lines which are present in the upper whorl near the body whorl of some *Nassa* spp are absent in *N. stolata.*

The head region conforms in most of the details with other neogastropods. The eyes are directly situated on the tentacles unlike *Alcithoe* spp which contain eyes on a short papillae (Ponder 1970). The penal duct like all neogastropods is sealed although open condition occurs in a few form like *Tudicula* (Abbott 1959).

In the families (Mitridae, Vexillidae, Marginellidae) that are modified far burrowing, the mantle cavity is placed for back on the right side (Ponder 1973). This type of arrangement is lacking in *N. stolata* which inhabit soft substrata. Some nitriform neogastropods like *Strigetella panpercula* have a large brown osphradium and a slightly longer ctenidium (Ponder 1972).

The digestive system of *N. stolata* is well suited for its food habits. This animal which mostly feeds on dead animals has a long pleurembolic probosis which enables it to reach the food at some distance. The radula shows lesser number of teeth which is well suited for tearing and rasping (Ponder 1973). The value of Leiblein which is the characteristic feature of neogastropods performs the important function of preventing food from returning to anterior oesophagus (Graham 1941).

The stomach of *N. stolata* is best modified according to its food habit. The two major regions of the stomach with its major and minor typhlosoles digest the flesh of dead organisms and the indigestible particles are being sorted out. Though the crystalline style was found to be absent in *N. stolata,* Brown (1959) reported the occurrence of one in/V. *obsoletus.* In general organisation of the reproductive system *N. stolata* follows the neogastropod pattern described by Pretter (1941). The prostate gland of this species is of closed type. Some primitive neogastropods like *Alcithoe arabica* contain open prostate glands as reported by Ponder (1970).

As the neogastropods evolved, the pallial groove became fused into a duct along its entire length (Pretter 1946). Wu (1973) has noted the existence of 3 types of prostate glands in Muricidae. Among the neogastropods, *Colus stimsoni* alone has a prostate which enters the body and coils among the lobes of salivary gland (West 1978). The penis of muricids and

buccinids are wide, blunt and considerably flattened dorsoventrally and the penis of nassarids, columbeilis and turrids are wide, tapering to a point and flattened or tubular, in addition to serve as an intramittant organ, penis also helps to hold the partner during copulation. The anterior vas deferens which is coiled in *Nassarius incrassatus* (Houston 1976) is almost straight <n this species.

The female reproductive system of *N. stolata* agrees well with the description given by Fretter (1941) for *N. reticulatus.* Johansson (1957) in his account on the reproductive system of *N. incrassatus* reported the occurrence of both seminal receptacle and ingesting gland which was later disputed by Honston (1976). But both these structures are found in *N. stolata* Houston (1976) observed in *Neptunea antigua* the division of the seminal receptacles into two sacs on each side of the ventral channel. But in the present study no such division in seminal receptacle could be established. Like all neogastropods the capsule gland occupies the largest part of the pallial oviduct.

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